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ABSTRACT

The aptitude-treatment interaction (ATI) design focuses on teacher effectiveness and on how the effectiveness of the teacher interacts with the stable characteristics of the student. The underlying assumptions of the ATI design are similar to and an extension of other teacher effectiveness research designs, such as the process-product design. The ATI research design can be used in examining questions related to physical education. Steps an ATI researcher would most likely pursue include: (1) Selecting treatments that have a foundational base in the literature; (2) Identifying aptitudes that have methods for reliable and valid measurement (The number selected should be manageable within the framework of the experimental design); (3) Identifying outcomes/skill measures (The skill being tested should be that skill being taught by the teacher); (4) Training teachers to execute the treatment as planned and teach the material that is being pretested or posttested; (5) Discerning and measuring aptitudes (Teachers or school records may be required to obtain information on aptitudes, and all appropriate regulations regarding privacy and student/subject rights must be respected); (6) Randomly assigning subjects (Unless true randomization of subjects is possible, a pretest is required); and (7) Measuring posttest skills to obtain the necessary information on student learning for each of the subjects and each treatment and aptitude level. (JD)

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APTITUDE-TREATMENT INTERACTION RESEARCH:

IMPLICATIONS FOR PHYSICAL EDUCATION

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This paper is based on a presentation at the Research Consortium Symposium titled Impediments to Research Paradigms Used to Study Teaching at the 1982 Annual Conference of the American Alliance for Health, Physical Education, Recreation and Dance, April, 1982, Houston, TX. At the time of the presentation the author was with the Department of Professional Preparation in Physcial Education at the University of Massachusetts/Amherst.

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What is Aptitude-Treatment Interaction Research?[1]

The aptitude-treatment interaction (ATI) design, in a general sense, primarily is concerned with how student characteristics affect or mediate what happens in the educational situation. The design focuses on teacher effectiveness and how the effectiveness of the teacher interacts with the stable characteristics of those students being taught.

Since the mid 1950's Cronbach (1957) has urged researchers to examine the role individual differences play in instructional methods and educational outcomes. With his colleague, Richard Snow, Cronbach coined the term Aptitude-Treatment Interaction. The term aptitude refers to any relatively stable student characteristic that may be a predictor of achievement. Gender, cognitive or psychomotor ability, past experience with the subject matter, IQ, socio-economic status, age, grade, and a number of other individual characteristics may be considered an aptitude.

A treatment is any manipulable variable and is similar to the process segment of the process-product model (Note 2). Treatment might be the amount of time engaged in practice, teacher questioning style, or method of instruction.

An interaction occurs when treatments produce significantly different effects in students with different levels of an aptitude. Interactions may occur when treatments are manipulated experimentally or when treatments are naturally occurring in the class. More precisely, in the classical experimental model, "an ATI exists whenever the regression of outcome from Treatment A, upon some kind of information about the

person's pretreatment characteristics, differs in slope from the regression of outcome from Treatment B on the same information" (Cronbach & Snow, 1977, pg. 5).

Essentially, this research method is an experimental design. In the most simple sense, it can be thought of like the two-way ANOVA with which we are familiar. The dependent variable is achievement in one of the three domains (psychomotor, cognitive, affective). The independent variable is the treatment and the blocked variable is the student characteristic. Remember, this is the most simple case -- the ATI design, in many instances, may be quite complex.

The underlying assumptions of the ATI design are, in many ways, similar and an extention of other teacher effectiveness research designs such as the process-product design. Process-product research tells us which variables may relate to achievement and even whether or not this relationship is mediated by certain student characteristics. When ATI research follows-up on correlational research findings it is in an attempt to "prove" causality. The assumptions of experimental or quasi-experimental research designs are incorporated into the ATI research design.

What are Typical Questions Asked By an Aptitude-Treatment Interaction Research?

The prime question in ATI research concerns achievement in one of the three domains and how levels of some treatment interact with the levels of the characteristics of the students in the study. This really asks two questions: 1) What are the overall effects of the treatment?; and, 2) What interaction is there between the treatment and the student

characteristics (aptitudes)? As you may know, when interaction effects exist these take precedence over the main effects and require careful interpretation.

A great deal of ATI research in classrooms has focused on the aptitudes of cognitive ability, psychological processes, socio-economic status (SES), sex, age, and grade. Treatments have focused on teaching styles, time-on-task, questioning styles, and teacher-student interactions styles, to name a few. The questions that an ATI researcher asks are related to the three facets of the design -- student achievement, treatment(s), and student characteristics(s).

Examples of questions one might ask if the ATI design is to be employed are:

1) What levels of student engagement produce the highest achievement and is this the same for high, medium, and low SES students?

or

2) In which of Mosston's styles do students achieve the most and is the same for males and females?

A more specific question related to physical education might be: At which level of teacher questioning do students best learn the forward pass and do internal and external locus of control students learn best under the same conditions? As can be seen by the above question, the answer to ATI questions may be involved and may require "finese" when presenting and interpreting results.

It should be pointed out that it is possible to ask inappropriate questions which focus on the ATI paradigm. Most of the inappropriate questions may involve too many simultaneous treatments in conjunction

with a wide variety of student characteristics. For instance, consider how difficult it would be to attempt to answer or interpret results stemming from this question: During which of Mosston's teaching styles, and various levels of questions do students learn the most and is this the same for students varying within the unique groupings of student psychomotor ability, SES, and sex?

The above question would have a number of different levels of interaction to interpret in addition to the main effects of teaching style, questioning levels, psychomotor ability, SES, and sex. The posing of ATI questions could, of course, be taken to the absurd. The important point is to carefully choose a small number of treatments and aptitudes which the research literature, or possibly common sense, may indicate as particularly potent for investigation.

At this time, one ATI study has been conducted with psychomotor skill improvement as the dependent measure. This was conducted by David Griffey (1981) now at the University of Texas at Austin. I have conducted a process-product study (Silverman, 1982) with special application of student characteristics as a prelude to future ATI research.

What Does an Aptitude-Treatment Interaction Researcher Actually Do?

This section will describe the steps an ATI researcher would most likely pursue in developing and implementing a teacher effectiveness study investigating aptitude-treatment interactions. Due to the complex nature and the number of steps, each step will be discussed in numerical order as listed. The reader is advised, however, that it could be possible to interchange the order of steps.

1. Identify treatments. The identification of treatments is more than merely deciding which teacher behaviors or methods should be the focus of the study. Treatments selected for an ATI investigation should have a foundational base in the literature of correlation/regression research. By this I mean, treatments should be selected when that treatment occurring naturally has been shown to be a particularly potent predictor of residualized outcome in earlier studies using the process-product model for research on teaching. When the researcher has an indication that a relationship exists between process and outcome, there is support of selection as a treatment of various levels of the behavior or among the teaching styles. When a treatment is selected without knowledge of it's predictive ability on outcome, the researcher may perform an involved experimental procedure with no foundation for the selection of the variables being studied. This may cause those doing the study to be frustrated by nonsignificant results. (N.B.: Results also may be nonsignificant if there were process-product relationships, but knowing that the relationship existed gives support for the selection of the treatment.) It would be wise for the researcher interested in teacher effectiveness not to skip the correlational level in pursuit of casuality.

2. Identify aptitudes. Aptitudes, like treatments, should be selected with care. If previous research has shown certain student characteristics have mediated process-product relationships, that would be a basis for selection of the aptitudes. Common sense, intuition, and characteristics which would have impact on pedagogical practice may make other characteristics inviting to the researcher. It is important that the aptitudes selected have methods for reliable and valid measurement

and that the number selected be manageable within the framework of experimental design.

3. Identify outcomes/skill measures. In any investigation focusing on student learning, the indentification and measurement of a pretest and posttest to obtain an outcome is very important. While the classroom researcher may have variety of reliable and valid tests for measuring student achievement, there are very few in physical education. Therefore, many teacher effectiveness studies in physical education have utilized previously designed instruments. Others, such as Bev Yerg, have designed elaborate systems to measure skill level. Whether a previously designed or new instrument is used, it is very important that the skill (or the cognitive concept or affective behavior) being tested is that skill being taught by the teacher. It is one thing to administer a pretest and posttest on serving a tennis ball when the serve is actually being taught and quite another when class time is spent practicing the volley or playing a game.

4. Train teachers. In an ATI study it is important that those teaching execute the treatment as planned and teach the material that is being pretested or posttested. A class where the treatment is not as designed or where the skills being taught are not the same as those being tested will obviously confound the analysis of the study. By planning ahead and working with those involved and by making certain each teacher is prepared to include the appropriate content and structure the class in ways consistent with the level of the treatment assigned, the investigator can help ensure the integrity of the study.

5. Measure aptitudes. Whatever aptitudes were selected for study

(Step 2) must now be measured. In some instances, students may have to be tested for psychomotor, cognitive, or affective attitudes. Teachers or school records may be required to obtain information on aptitudes. No matter which way aptitudes are discerned, the investigator should be certain to go through proper channels and to abide by all appropriate regulations regarding privacy and subject rights.

6. Random assignment. If the study is to utilize a true experimental design, random assignment of subjects would occur at this point. It should be noted that this is rarely possible and, therefore, the study would be a non-randomized experimental nature.

7. Pretest skill. Unless true randomization of subjects within treatments by aptitudes is possible a pretest is required. The pretest should be administered consistent with guidelines presented earlier and in non-randomized experiments serves a function similar to the covariant in analysis of convariance.

8. Implement treatments. Once aptitudes have been measured and a pretest has been administered, the experimental treatments are initiated as planned earlier. An ambious (and prudent) researcher might make certain that each treatment is being reliably implemented throughout the course of study.

9. Posttest skill. The final step prior to analysis is to posttest the skill. The posttest, after considering the pretest, will give the researcher necessary information on student learning for each of the subjects and for each treatment and aptitude level.

10. Analyze data. Analyzing the data from ATI studies may be intricate, since rarely can students and/or classes be truly randomized in accordance with the assumptions of the familiar randomized

experimental models. Therefore, methods for analyzing non-randomized experiments should be employed. The reader might start by reading the recent paper by Griffey (1982) and then consulting other references or an experienced educational statistician prior to developing a strategy for analyzing ATI data.

What are the Major Methodological/Instrumentation Considerations in Aptitude-Treatment Interaction Research?

Many of the concerns related to methods and instrumentation have been presented in other parts of this paper. As discussed earlier, the researcher does need to be concerned with the reliability and validity of the treatments and the measures for assessing skill level and aptitudes. The concerns should be thought out and addressed prior to the initial undertaking of the study.

An issue in measuring skill level or outcome is the test-retest reliability of the performance. This may be particularly important when a fluid skill is the focus of investigation. A system has to be devised (or found) to have raters reliably rate the skill among each other. There is another concern--is that performance of the skill that has just been rated an accurate indication of the students' "real" skill level. The researcher must be concerned with these two issues as well as others. A well thought out and tested skill measurement and data analytic system greatly will enhance any study, but the researcher should be aware that no method is perfect and some will find fault no matter how many precautions are taken.

The issue of generalizing an ATI study to other populations will depend on many factors which are generally well known. If the study is

random the principles of general ability that apply to randomized experiments will hold true. If the study is non-randomized or quazi-experimental, only limited generalizations, if any, can be made to subjects other than those involved in the study. Of course, if we find many replications showing similar results in a variety of environments from variety of researchers, we may individually interpret the findings to provide a foundation for understanding what is happening with certain aptitudes and treatments in the gymnasium.

One final note concerning methods relates to the issue of the proper unit of analysis. Early in the planning stages the researcher will want to determine the most appropriate unit (student, class, school, etc.) for analyzing the data from the study. This is an important and controversial issue and should be confronted as <u>early</u> as possible.

REFERENCE NOTES

1. The symposium was organized to address each of the questions which serve as headings for the sections of this paper.
2. Other paradigms selected for presentation at the symposium and the presentors are: Process-Product Research Models in Physical Education, Beverly Yerg and Bernard Oliver; Single-Subject Research Design, Patt Dodds and Thom McKenzie; Ethnographic/Ethnomethodological Research, Tom Templin. The symposium was organized and moderated by Bernard Oliver.

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